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ABSTRACT

An overview of Noam Chomsky's theories about transformational grammar and phonology is given. Since Chomsky was interested in characterizing what it is to know a language, the ways in which we demonstrate knowledge of our native language are discussed in detail. Particular emphasis is placed on describing how the transformational approach actually works. The differences between transformational theory and structural linguistics are also pointed out. In the second part of the present work, there is a brief discussion of the transformational grammarian's theory of psycholinguistics, called cognitive psycholinguistics. The discussion focuses on a comparison of cognitive psycholinguistics and classical behaviorist learning theory. (PMP)

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TRANSFORMATIONAL GRAMMAR AND COGNITIVE PSYCHOLINGUISTICS.

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Introduction

The following is a chapter from a monograph in progress tentatively titled "The Impact of Transformational Grammar on Foreign Language Teaching." The chapter is taken from a section of the monograph called "Background." The monograph is an example of one kind of research being carried out in the Language in Culture research area of the Culture Learning Institute. Currently, Language in Culture is mainly concerned with two broad areas: (1) the study of the social and personal factors that influence language behavior (what might loosely be termed sociolinguistics), and (2) teaching English to speakers of other languages.

In this latter area, Language in Culture has been most active on two fronts, conducting in-service training programs in English language (and supporting degree students at the University of Hawaii), and in supporting research on English language curriculum design and in the developing of actual English language teaching materials. The monograph is an example of research on the theory of English language curriculum design.

Language in Culture also plans to conduct actual projects in curriculum and materials writing. One such project will bring participants together from Asia, the Pacific and the United States to work on a curriculum or a set of materials appropriate to their own situations. We hope that by providing the participants with specialized resources of the Culture Learning Institute (and the University of Hawaii) they will be able to do much more sophisticated work than they could in isolation in their own countries.

Background for English Language Curriculum

Before discussing the impact of transformational grammar on the English language curriculum, it might be useful to provide some background information about transformational grammar and its corresponding theory of psycholinguistics, which for lack of a better term, I will call cognitive psycholinguistics. In the brief overviews below, the focus will be on those aspects of transformational grammar and cognitive psycholinguistics that are relevant to the English language curriculum. Accordingly, some otherwise important aspects of the history of the two disciplines will not be touched on.

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Transformational grammar was largely the invention of one man--Noam Chomsky. A general outline of transformational grammar first appeared in Syntactic Structures in 1957. In 1965 Chomsky expanded and modified the original theory of transformational grammar in Aspects of the Theory of Syntax. In 1968 Chomsky (with Morris Halle) dealt with the phonological side of the theory in The Sound Pattern of English.

Perhaps the easiest way to make an initial rough characterization of transformational grammar is in terms of the basic distinction it draws between what people know and what they say. Chomsky was interested in characterizing what it is to know a language. Broadly speaking, our knowledge of our own language is manifested in three ways: (1) by our ability to distinguish grammatical and non-grammatical sentences in our language, (2) by our ability to perceive the tacit relation of parts of a sentence to other parts of the same sentence, and (3) by our ability to perceive the grammatical relation between different sentences.

At first glance, the problem of grammaticality seems trivial. We recognize the grammatical sentences in our language because we have previously encountered them. All the rest are ungrammatical. However, when we look at the huge magnitude of the number of possible sentences, we can easily see that grammaticality is not a function of exposure to known grammatical sentences. For example, taking even a highly restricted vocabulary of 10,000 words, the number of possible three-word combinations is 1,000,000,000,000. Suppose that only one out of every one thousand-word combinations is actually a grammatical sentence. Even then, it would take over thirty-one years of listening to three-word sentences at the rate of one a second, twenty-four hours a day, 365 days a year to just hear them all once. Obviously, exposure and memory are not adequate to explain grammaticality.

A speaker's ability to make judgments about grammaticality must involve some kind of abstraction on the speaker's part. For example, the classification of words into the abstract classes of parts of speech enables us to make strong generalizations about the nature of grammatical sentences. Virtually all the grammatical three-word sentences in English are made up of the following sequences of word classes:

Article Noun Verb (example: The roof leaks.)

Noun Verb Adjective (example: John is tall.)

Noun Verb Adverb (example: John is here.)

Noun Verb Noun (example: Birds eat worms.)

Noun Verb Preposition (example: John calmed down.)

Verb Article Noun (example: Shut the door!)

All other combinations of word classes will produce ungrammatical sequences, for example, Noun Noun Noun, Article Verb Noun, Verb Preposition Verb and so on.

There are many areas of English grammar that show that our judgments about grammaticality depend on our intuitive use of very complex abstractions. One illustration of this is in the complex grammatical dependencies found in the formation of the tag question. Any statement in English can be turned into a tag question. Here are some examples:

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Statement	Tag Questions
Today is Tuesday.	Today is Tuesday, isn't it?
John can swim.	John can swim, can't he?
Alfred isn't ready.	Alfred isn't ready, is he?
The boys haven't started yet.	The boys haven't started yet, have they?

In order to be grammatical, the tag question must meet the following conditions: the tag part must use the same verb (or first auxiliary verb if there is more than one); it must make a positive-negative switch (that is, if the statement is positive, the tag part must be negative; if the statement is negative, the tag part must be positive); and finally, the tag part must end with a pronoun that is the correct substitute for the subject of the statement. If the first or third of these conditions is violated, the resulting sequence is ungrammatical, for example: *Today is Tuesday, doesn't it? and *Today is Tuesday, isn't they? If the second condition is violated the result is not a tag question but an echo question with an entirely different meaning: Today is Tuesday, is it?

Another example of a different kind of complexity is found in the rules that govern the formation of the comparative. The following comparative sentence

John is taller than his father is tall

would normally be said in a more contracted form. We would say either

John is taller than his father is

or

John is taller than his father.

The rule seems to be that those elements on the right-hand part of the comparison which are identical with their corresponding element on the left-hand part can be deleted. However, this is not so. For example in the following sentence

John is taller than his father is wide

we cannot delete the second is:

*John is taller than his father wide.

In a somewhat similar construction where two sentences are conjoined, this deletion is possible. For example, we can say either

John is tall and his father is wide.

or

John is tall and his father wide.

The rule which governs the deletion in comparative sentences appears to work on a right to left basis. That is, if the right-most element in the right-hand side of the comparison is identical with its counterpart on the left, it may be deleted (tall in the first example). The rule then applied to what is now the new right-most element (is in the first example). This cyclical, right-to-left application of the rule explains why

*John is taller than his father wide

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is ungrammatical. Since wide and tall are different, no further application of the rules is possible. If the adjectives were identical but the verbs were different, the second adjective would be deleted, but not the verbs. For example from the sentence

John is taller than his father was tall

we get the deleted form

John is taller than his father was.

The was cannot be deleted without making the sentence ungrammatical in the intended meaning.

The examples have illustrated three kinds of abstract relations: categorical abstractions (parts of speech), dependency relations between abstractions (the tag question), and restrictions on the application of an abstract grammatical rule (the comparative rule). In order to distinguish grammatical sentences from nongrammatical sentences, speakers of the language must be able to employ these kinds of abstract grammatical relations.

The second way that our knowledge of our own language is manifested is by our ability to perceive the tacit relation of parts of a sentence to other parts of the same sentence. Dr. Roderick Jacobs gives a striking example of this by the following pair of sentences:

Cinderella ordered her sisters to clean the room.

Cinderella promised her sisters to clean the room.

Speakers of English know that in the first sentence her sisters are going to clean the room while in the second sentence, Cinderella is going to clean the room. There is no overt signal in the sentence that tells us the relation of the infinitive phrase to clean the room to the rest of the sentence. We know the difference because we know the kinds of complements that must follow the verbs order and promise: we order someone to do something, but we promise someone that we will do something ourselves.

Another example of the same point is in the pair of sentences

John started to answer the phone.

John stopped to answer the phone.

In the first example, to answer the phone is the complement to the verb start. That is, it is a necessary part of the sentence. If it is deleted, the sentence becomes ungrammatical in the intended meaning: *John started (John started to do what?). In the second example to answer the phone is an optional adverbial element that tells why John stopped. Again, there is no signal in the sentence that tells us how to interpret the function of to answer the phone. We are able to because we have a knowledge of the relation between parts of a sentence. In this case, we know that the verb start takes an infinitive complement and that the verb stop does not.

The third way that our knowledge of language is manifested is through our ability to perceive the grammatical relation between different sentences. We have already had one example of a systematic grammatical relation between statements and tag questions. There are numerous other examples of pairs of sentences which have a systematic grammatical (and semantic) difference. For example, for every statement, there is a corresponding yes-no question (example: Today is Tuesday--Is today Tuesday?), and a question which asks for information (example: Today is Tuesday--What is today?). For every grammatical positive statement, there exists a corresponding negative statement using not (example: Today is Tuesday--Today is not Tuesday). For every neutral or

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unemphatic statement there is a corresponding emphatic statement the asserts the truth-value of the statement (example: Today is Tuesday--Today IS Tuesday!). That the emphatic form is more than just a matter of stress is seen with a sentence that does not use the verb be or an auxiliary verb (example: We won the game--We DID win the game! Here the emphatic form requires the addition of the verb do).

There is another type of grammatical relationship called paraphrase. In the examples above, there is a systematic difference in meaning between the pairs of sentences. In a paraphrase relationship, the two related sentences have the same meaning. A good example of a paraphrase relationship is in the two-word verb construction. A two-word verb is a verb plus preposition unit that makes up one lexical word. Look over is a two-word verb which means "examine."

The examiners looked over the books.

With some two-word verbs it is possible to move the preposition to a position after the object. Look over is such a verb:

The examiners looked the books over.

Thus the two sentences

The examiners looked over the books

The examiners looked the books over

are in a paraphrase relationship with each other: they both mean the same thing and they are related to each other in a systematic grammatical way.

The active-passive relationship is one of the most complex paraphrase relations in English. For example, for the active sentence

John took the message

there is the corresponding passive sentence

The message was taken by John.

The active-passive paraphrase relationship is particularly interesting because of the great difference in form between them. Quite literally, the active and passive have only one grammatical element in common: they have different subjects, different verb tenses, and different objects; the only shared element is the main verb (take in the case of the example above). Despite their striking formal differences, it is clear that the active and passive have the same basic meaning and that they are related in a systematic way.

The final example of the relationship between two sentences is almost the opposite of the paraphrase relationship. In the paraphrase relationship, two different sentences have the same meaning. In this new relationship, one apparent sentence has two different meanings. In other words, it is an ambiguous sentence. An ambiguous sentence is really two different sentences that happen to look exactly alike in the same way that to and two are different words that happen to sound alike. The classic example of an ambiguous sentence comes from Chomsky's Syntactic Structures (p. 88). Chomsky's example is the phrase the shooting of the hunters which means either (1) the hunters shot something or (2) someone shot the hunters. The interesting thing about this example is that both meanings have exactly the same grammar: the is an article, shooting is a gerund, of is a preposition, and hunters is a noun.

One possible explanation would be to claim that this particular sequence of Article--gerund--of--article--noun is inherently ambiguous in the same way that read is inherently

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ambiguous as either the present tense or the past tense written form of the verb. Chomsky shows that this cannot be the case by giving exactly parallel constructions which are not ambiguous:

the growling of the lions

the raising of the flowers.

Moreover, the growling of the lions is similar to the first meaning of the shooting of the hunters (lions growl and hunters shoot) while the raising of the flowers is similar to the second meaning (someone raises the flowers and someone shoots the hunters).

The trick about this group of gerundive phrases is that the noun at the end represents either an original subject of a sentence (as in Lions growl) or an original object (as in [Someone] raises flowers). Chomsky's the shooting of the hunters is ambiguous because hunters can be either the original subject (Hunters shoot) or the original object ([Someone] shoots the hunters). The other two phrases are not ambiguous because lions cannot be an object (*[Someone] growls lions) and flowers cannot be a subject (*Flowers raise [something]).

We have now seen some examples of all three ways in which knowledge of our language is manifested: by our ability to distinguish grammatical sentences from nongrammatical sequences, by our ability to perceive tacit relations within a sentence, and by our ability to perceive grammatical relations between sentences. All three abilities imply the same thing: knowledge of a language entails the knowledge and use of a complex set of grammatical abstractions that cover the language. How this knowledge is acquired and how the brain uses it is unknown. Chomsky's goal, however, was much more limited. He was interested in characterizing this knowledge. The device he invented to do this was a transformational grammar. (The term grammar here refers how words are arranged to form sentences. The pronunciation of the sentences belongs to the area of linguistics known as phonology. Transformational phonology will be discussed below.)

The exact form of this grammar and how much knowledge it is expected to account for is controversial. However, for our purpose, it is sufficient to recognize two sets of rules in the grammar. The first set is called the phrase structure rules. These rules produce elementary Dick-and-Jane sentences. The second set of rules, the transformational rules, combines the elementary sentences produced by the phrase structure rules, collapses them together, and "transforms" them into normal sentences. Perhaps a helpful analogy is to think of the sentences produced by the phrase structure as basic chemical structures. The transformational rules are the rules of chemistry which govern the ways in which the basic structures are combined and reshaped to form more complex compounds.

In his book Aspects of the Theory of Syntax Chomsky coined the terms "deep" and "surface" to talk about the relations between the two sets of rules in a transformational grammar. The surface structure of a sentence is the part of speech analysis of the sentence as it appears. The deep structure of the same sentence, however, is a listing of all the elementary sentences produced by the phrase structure rules that are necessary to account for the surface sentence. The deep sentences are covered into the surface sentence by the transformational rules. Thus the relation between the deep and surface structures is a "before" and "after" relation: the deep structure is before the transformational rules have been applied, and the surface structure is after they have been applied.

The terms deep and surface are especially convenient for talking about paraphrase and ambiguity. In a paraphrase relation, the two related surface sentences come from a single deep structure. The surface sentences differ because they have had different transformational rules applied in the process of their derivation. To take an obvious example,

The examiners looked over the books

The examiners looked the books over

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have different word orders because the second sentence has been derived with an optional transformational rule that moves the preposition after the noun. In the relation between the active and passive, the passive has had a whole battery of transformational rules applied to it that have not been applied to the passive.

The ambiguous sentence is just the opposite. Ambiguity results when two different deep structures end up producing exactly the same surface structures. This points up the fact that most deep structures can come to the surface in a variety of slightly different forms. Some of these forms may happen to be identical with forms derived from a different deep structure. If this happens, we then have an ambiguous sentence.

As an example of how a transformational grammar deals with ambiguity, let us take the ambiguous phrase the shooting of the hunters. As pointed out above, there appear to be two different deep structure sentences underlying this one surface phrase: (1) The hunters shot something and (2) Someone shot the hunters. The phrase the shooting of the hunters is sometimes called a nominalization in transformational terms because it is a sentence that has been turned into a noun phrase, that is, the nominalization can be put inside another sentence. For example, in the following sentence

The shooting of the hunters surprised us

the nominalization serves as the subject. In the following sentence

We heard the shooting of the hunters

it serves as the object.

There are many ways that an underlying sentence can be nominalized. For example, the hunters shot something can be changed into the hunters' shooting of something or the hunters' shooting something, or even the fact that the hunters shot something. However, to account for the ambiguous form, we need first to delete the object of the original sentence by an optional transformational rule, changing the hunters shot something into the hunter's shot. This new sentence then nominalizes into the shooting of the hunters.

The other underlying sentence something shot the hunters requires other transformations before it can be nominalized to produce the ambiguous form. First, the active sentence someone shot the hunters must be transformed into the passive sentence the hunters were shot by someone. The agent by someone is next deleted by a second transformational rule, producing the hunters were shot. When this sentence is nominalized, one of the resulting forms is the ambiguous phrase the shooting of the hunters. The nominalization rule applies equally to active and passive sentences, hence the ambiguity of the phrase the shooting of the hunters. Notice that in both derivations, the ambiguous form could only be produced by deleting the other noun in the underlying sentence, the original object in the first underlying sentence and the original subject in the second. Thus in the ambiguous phrase, you cannot tell whether hunters is the subject or object of the verb shoot.

Up to this point we have been concerned only with grammar. When we turn to phonology and the relation between grammar and phonology we see perhaps the greatest difference between transformational grammar (now using grammar in a broad sense including phonology) and the theory it supplanted, structural linguistics. In structural linguistics, the investigation of language moved from the most concrete to the least concrete, in other words, from phonology to a consideration of meaning. We have seen that in syntax, a transformational grammar moves in just the opposite direction: from abstract (i.e., the deep structure) to concrete (i.e., the surface structure).

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Structural linguistics and transformational grammar take opposite scientific approaches. Structural linguistics is Baconian in its insistence on the primacy of data and in its distrust of generalizations and abstractions. Transformational grammar, on the other hand, is basically a mathematical model of language that works deductively from abstractions down to particular cases.

In transformational phonology the same movement from abstract to concrete is preserved. The abstract starting point for the phonological rules is the output of the transformational rules in the grammar--the surface structure of the sentence with all the words spelled in the usual way and with all the information about each word's part of speech and how the words interrelated to make up the grammar of the whole sentence. The surface structure plays a double role: from the standpoint of syntax, the surface structure is concrete (compared to the abstractions in the deep structure), but from the standpoint of phonology, the surface structure is abstract (compared to the concreteness of pronunciation). Thus again the output for one set of rules serves as the input for the next set of rules. The output of the phonological rules is a phonetic representation of the pronunciation of the surface structure sentence that was the original input.

It might be helpful in seeing how the two theories relate phonology to grammar by giving their different analysis of an actual sentence. The following sentence is ambiguous:

John fed her dog biscuits.

Either her is possessive, that is, John fed dog biscuits to her dog, or her is the indirect object, that is, John fed dog biscuits to her. When the sentence is said aloud, one interpretation or the other must be picked since the two interpretations have different pronunciations. If the first meaning is picked, there is a slight pause after dog, and biscuits has a higher stress than dog. In the second meaning, there is a pause after her, and dog biscuits is pronounced as a compound noun, that is, with higher stress on dog than on biscuits. The two theories give completely different interpretation to these facts. The structural linguist would point out that since the pronunciation disambiguates the two sentences, the information from pronunciation (i.e., phonology) is necessary to understand the meaning of sentences. In other words, grammar must follow and be dependent on phonology. The transformational grammarian, however, would argue that we know how to pronounce the ambiguous sentence in two different ways because we know that it is really two different sentences, i.e., comes from two different deep structures. The fact that the two different surface sentences are pronounced differently has nothing to do with our interpretation of them, nor does it explain how we knew how to pronounce either sentence to begin with.

The transformational view is that you can only embody in speech what you can analyze on the level of surface structure. This is not to say that you can only pronounce those sentences that you can understand. It is perfectly possible to open a philosophy book and correctly read a sentence aloud without understanding its meaning. You can read it aloud because you know all the words and their grammatical relation to each other, i.e., the surface structure.

There are two sets of rules that convert the surface structure into a phonetic representation of actual speech. One set assigns an overall stress contour to the entire sentence. For example, this set of rules would have to make different stress assignments for the two different meanings of black + board: if black is an adjective, board will receive primary word stress; however, if blackboard is a compound noun (information contained in the surface structure), then black receives primary word stress.

The second set of rules deals with the pronunciation of individual words, including placement of stress, reduction and shifting of vowels, and the relation of the word to other members of its word-family. For example, atom has the primary word stress on the first syllable, but atomic has it on the second. Atomic is an adjective derived from the noun atom by means of the derivational suffix -ic. The shift in stress from the first

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syllable in atom to the syllable before the derivational suffix in atomic is part of a larger, regular pattern; for example: irony-ironic, telegraph-telegraphic, photography-photographic, algebra-algebraic etc. Moreover, the shift of stress has affected the quality of the vowels. Atom has a distinct low-front vowel in the first syllable but an uncontrastive vowel in the second vowel. In atomic the position of the distinct and uncontrastive vowels reverse: the distinct vowel is now in the second syllable while the uncontrastive is in the first syllable.

The beginning point for the set of rules that governs word pronunciation is the normal orthographic spelling for the word. Chomsky and Halle take this as their initial abstract input. The rules apply to this form and convert it into a representation of the word's pronunciation. The spelling of a word represents information about the word family it belongs to. With that knowledge, Chomsky and Halle's rule set is able to correctly assign a pronunciation to the word. Thus the spelling atom serves as the ideal abstract (or underlying) representation for both atom and atomic: the spelling provides the information for determining the nature of the vowel in the stressed syllable no matter which syllable gets the word stress. In other words, the spelling underlies both pronunciations.

To the structural linguist the ideal writing system would provide a one-to-one match between the sound and the spelling, i.e., the same sound would always be spelled the same way. In transformational phonology the ideal writing system would always spell the same word the same way, no matter how it was pronounced. Chomsky and Halle's (1968) basic assumption is that once a native speaker of English can correctly assign part of speech to a word and can fit the word into its word family, he will know how to pronounce it. This knowledge is characterized in terms of a set of phonological rules starting with the surface structure in normal orthographic spelling. Here is Chomsky and Halle's comment about their use of orthographic spelling as the abstract input for their rules:

> There is, incidentally, nothing particularly surprising about the fact that conventional orthography is, as these examples suggest, a near optimal system for the lexical representation of English words. The fundamental principle of orthography is that phonetic variation is not indicated where it is predictable by general rule. Thus, stress placement and regular vowel or consonant alternations are generally not reflected. Orthography is a system designed for readers who know the language, who understand sentences and therefore know the surface structure of sentences. Such readers can produce the correct phonetic forms, given the orthographic representation and the surface structure, by means of the rules that they employ in producing and interpreting speech. It would be quite pointless for the orthography to indicate these predictable variants.... A system of this sort is of little use for one who wishes to produce tolerable speech without knowing the language--for example, an actor reading lines in a language with which he is unfamiliar. For such purposes a phonetic alphabet, or the regularized phonetic representations called "phonemic" in modern linguistics, would be superior. This, however, is not the function of conventional orthographic systems (1968, p. 49).

To summarize, in both grammar and phonology, the transformational approach works by applying a set of rules to an abstract, underlying form. In the area of grammar, the underlying forms are produced by the phrase structure rules, and are called deep structures. The deep structures are converted into surface structures by the application of the transformational rules. In the area of phonology, the grammatical information contained in the surface structure provides the abstract, underlying forms for the determination of sentence stress. The forms are given their relative sentence stress by a set of phonological rules. Finally, the placement of word stress in polysyllabic words and the systematic changes in pronunciation that go with stress are determined by a second set of phonological rules that apply to the abstract, underlying form provided by the normal English orthographic spelling.

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We will now turn to a brief discussion of cognitive psycholinguistics. Of greatest interest to us is the way in which cognitive psycholinguistics offers a new alternative to what might be loosely called classical behaviorist learning theory. Within the classical view of behaviorism, there are many different models of how learning takes place, and indeed, different definitions of what learning is. One model (Pavlov's classical conditioning) defines learning as a demonstration of the learner's ability to associate. To take an example from language learning, the ability of a native speaker of Japanese to give Japanese equivalents for English words is a demonstration of his learning of English vocabulary, i.e., he has learned to associate English and Japanese words.

A second model (that of C. L. Hull) looks at learning primarily in terms of habit strength. An example here would be the learner's struggle to develop new habits of pronunciation for the language he is acquiring. Part of his difficulty is the interference of the well established habits in his native language with his attempts to establish new habits for the foreign language. A third model, and one that is particularly interesting to language teachers, is B. F. Skinner's instrumental learning. Instrumental learning differs from Pavlov's classical conditioning in that instrumental learning alters the learner's behavior by rewarding the learner's response, while Pavlov's conditioning caused learning to take place by the simple juxtaposition of two stimuli. For Skinner, learning is the mastery of a new set of accomplishments which can be demonstrated on demand. An example would be the ability of a language learner to produce sentences in the new language appropriate to the situation.

Despite real differences between the models described above, they have three fundamental points of similarity: (1) All models agree that the principles of classical behaviorist learning theory can account for all forms of human learning, even language, even though the models were developed in tightly controlled laboratory experiments often involving relatively lower-order animals. In other words, classical behaviorist learning theory is a universal explanation for all learning. (2) All models describe learning in terms of some change in the learner's overt behavior, i.e., learning implies some measurable action on the part of the learner. (3) All models agree that learning takes place because of some change in the learner's environment, though the models disagree on what the key variable for the change is: stimulus, response, reinformant, number of trials etc.

Cognitive psycholinguistics is not a general challenge to all of classical behaviorist learning theory. There are many types of learning, even in humans, that classical behaviorist learning theory gives a convincing account of. The main difference between cognitive psycholinguistics and classical behaviorist learning theory stems from the special status that the cognitive psycholinguists give to the learning capacity of the human brain in general and to its capacity to acquire language in particular. The cognitive psycholinguists claim that the human capacity for language is an innate, species-specific quality of the mind, and consequently, must be acquired in species-specific ways. In other words, the cognitive psycholinguists deny the first of the three points shared by all models of classical behaviorist learning theory, namely, that their theories are a universal explanation for all learning.

Chomsky has argued that classical behaviorist learning theories have concentrated on an organism's learning what is not intrinsic to the needs of the organism's species, for example, Pavlov's conditioning a dog to salivate at the sound of a bell or Skinner's conditioning a pigeon to play ping-pong. Chomsky feels that these studies shed little light on how organisms acquire species-specific behavior--behavior that is intrinsic to the species. As Chomsky puts it:

> The problem of mapping the intrinsic cognitive capacities of an organism and identifying the systems of belief and the organization of behavior that it can readily attain should be central to experimental psychology. However, the field has not developed in this way. Learning theory has, for the most part, concentrated on what seems a much more marginal topic, namely, the question of species-independent

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> regularities in acquisition of items of a "behavioral repertoire" under experimentally manipulable conditions. Consequently, it has necessarily directed its attention to tasks that are extrinsic to an organism's cognitive capacities--tasks that must be approached in a devious, indirect, and piecemeal fashion (1965, pp. 56-57).

The following train of reasoning is implicit in the cognitive psycholinguist's rejection of the classical behaviorist learning theory's claim to a universal explanation: (1) Human language is literally species-specific, i.e., it is profoundly different from any kind of animal communication (see Hewes 1973, pp. 6-7 for a survey of the literature on the difference between human language and primate communication). (2) The human brain has its own rich, innate (i.e., genetically determined) capacity that makes language learning "natural" for humans and impossible for other species. In Aspects of the Theory of Syntax, Chomsky briefly characterizes what this innate capacity for language must consist of:

> A child who is capable of language learning must have
>
> (i) a technique for representing input signals
>
> (ii) a way of representing structural information about these signals
>
> (iii) some initial delimitation of a class of possible hypotheses about language structure
>
> (iv) a method for determining what each such hypothesis implies with respect to each sentence
>
> (v) a method for selecting one of the (presumably, infinitely many) hypotheses that are allowed by (iii) and are compatible with the given primary linguistic data (1965, p. 30).

(3) The concluding assumption, following from the first two, is that the human capacity for language acquisition is unique and cannot be described in terms of a universal explanation provided by classical behaviorist learning theory.

It is difficult to imagine anyone challenging the first assumption above. For a particularly interesting discussion on the relation between human language and animal communication and the whole question of the evolution of language, see Chapter Six, "Language in the light of evolution and genetics," in Lenneberg's (1967) Biological Foundations of Language. Investigations of children's acquisition of their first language and clinical studies of impared children have strongly supported the second assumption. For surveys of recent research on normal acquisition of first language, see Dale 1972, McNeill 1970, Reed 1971, and Slobin 1971. Lenneberg 1967 is still the classical work on language in impared children.

However, there is virtually no independent evidence that bears on the third and concluding assumption. That is, even granted that human language is possible only because of the genetic make-up of the human brain, that does not of itself prove that human acquisition of language must take place in a unique way. Moreover, it is hard to imagine what kind of evidence would independently prove (or disprove) that it does. MacCorquodale in his article on Chomsky's (1959) review of Skinner's Verbal Behavior (1957) argues, in effect, that the principles of behaviorist learning are empirically well established across many species, each with its own genetic pecularities. Thus the burden of proof is on the cognitive psycholinguist to show that human language learning requires a special set of learning laws for its own. As MacCorquodale (1970) puts it:

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> There is no lethal incompatibility or even mild inconsistency between the principles of genetic evolution and the principle of reinforcement. Reinforcement has many necessary points of contact with genetics. Reinforceability is itself a genetically determined characteristic; organisms are simply born reinforceable. They have evolved that way. The fact that organisms behave at all is due to genetic determination. Stimulus generalization and response induction are genetically determined characteristics (1970, p. 33).

Nevertheless, the mounting evidence supporting the cognitive psycholinguists' first two assumption make the third assumption a serious challenge to one of the basic tenets of classical behaviorist learning theory.

The second point that all models of classical behaviorist learning theory shared was that learning could only be described in terms of some change in the learner's overt behavior. Chomsky has argued the opposite point, at least as far as language is concerned, in his distinction between competence and performance. Competence is a person's linguistic capacity. Performance is what he does with that capacity. Performance, i.e., actual observed behavior, is not the same thing as competence because performance is partly the result of factors that have nothing to do with the person's underlying competence. For example, performance has both accidental limitations, e.g., slips of the tongue, false starts, etc., as well as systematic differences from competence, e.g., memory limitations. In Chomsky's "Formal discussion of 'The Development of Grammar in Child Language' by Wick Miller and Susan Ervin," (Chomsky, 1964), he analogizes linguistic competence and performance with competence and performance in mathematics: the fact that we know how to multiply (what we might call mathematical competence) does not mean that we will not make mistakes (accidental limitations) or can multiply two long numbers together without pencil and paper (memory limitations) in our actual performances of multiplication.

Thus for the cognitive psycholinguist, the crucial part of language learning is the learner's development of linguistic competence. However, this development takes place, as it were, behind the scenes. The learner's actual performance gives us only hints and suggestions about his development of competence. Moreover, the learner is never presented with models of competence to emulate; he is only exposed to instances of performances. As Chomsky puts it:

> The problem for the linguist, as well as for the child learning the language, is to determine from the data of performance the underlying system of rules that has been mastered by the speaker-hearer and that he puts to use in actual performance. Hence, in the technical sense, linguistic theory is mentalistic, since it is concerned with discovering a mental reality underlying actual behavior. Observed use of language or hypothesized dispositions to respond, habits, and so on, may provide evidence as to the nature of this mental reality, but surely cannot constitute the actual subject matter of linguistics, if this is to be a serious discipline (1965, p. 4).

The third point that all models of classical behaviorist learning shared was that learning took place because of some change in the learner's environment. Cognitive psycholinguists argue that, on the contrary, a child's acquisition of his first language is largely an internal affair because the child must create for himself an abstract set of grammatical rules that cover the data he is exposed to. As Chomsky puts it in his "Review of Skinner's Verbal Behavior":

> The child who learns a language has in some sense constructed the grammar for himself on the basis of his observation of sentences and non-sentences (i.e., corrections by the verbal community). Study of the actual observed ability of a speaker to distinguish sentences from

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> non-sentences, detect ambiguities, etc., apparently forces us to the conclusion that this grammar is of an extremely complex and abstract character, and that the young child has succeeded in carrying out what from the formal point of view, at least, seems to be a remarkable type of theory construction. Furthermore, this task is accomplished in an astonishingly short time, to a large extent independently of intelligence, and in a comparable way by all children. Any theory of learning must cope with these facts (in Jakobovits and Miron, 1967, pp. 170-171).

In other words, the cognitive psycholinguist's position is that the child is born with a genetically determined knowledge of how natural language work and with a special ability at hypothesis formation and testing to determine which hypothesis is correct. As might be imagined, there is little direct evidence to support this position except for (1) the amazing speed with which learners acquire their first language and (2) general patterns in the sequence and rate that language elements are learned (for details, see the survey works referred to on page). However, there is considerable negative evidence accumulating against the environmental shaping of children's language development through (1) imitation of adult models, (2) parental correction, or (3) need to communicate. In a recent article, Roger Brown (1973) discussed these topics and comes to this conclusion:

> In sum, then, we presently do not have evidence that there are selective social pressures of any kind operating on children to impel them to bring their speech into line with adult models. It is, however, entirely possible that such pressures do operate in situations unlike the situation we have sampled, for instance, away from home or with strangers. A radically different possibility is that children work out rules for the speech they hear, passing from levels of lesser to greater complexity, simply because the human species is programmed at a certain period in its like to operate in this fashion on linguistic input (pp. 105-106).

Whether or not the acquisition of human language proves to be an exception to the generalizations of classical behaviorist learning theory, only time will tell. Clearly, however, transformational grammar and cognitive psychology have raised issues that are not going to go away.

It might be useful to have here a brief summary of the key differences between classical behaviorist learning theory and cognitive psycholinguistics:

Classical behaviorist learning theory	Cognitive psycholinguistics
(1) All forms of learning are basically alike.	(1) Language learning is a species-specific form of behavior and takes place in species-specific ways.
(2) Learning can only be described in terms of overt behavioral changes.	(2) Language learning can only be described in terms of the growth of linguistic competence (as opposed to overt performance).
(3) Learning takes place through some change in the learner's environment.	(3) Language learning is an act of individual creation through hypothesis creation and testing.

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